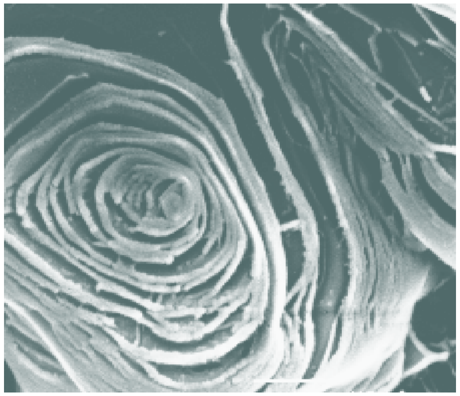
A Self-Replenishing Solid Lubricant



Argonne scientists have developed a elf-replenishing lubricant – boric acid – that reduces riction and wear and maintains high-precision motion n mechanical assemblies. When used as a lubricant, ›oric acid outperforms competing products; costs less; nd is abundant, nontoxic, and environmentally safe.

Argonne is licensing the boric acid technology for a ariety of applications, including its use as a lubricant for ;ears, bearings, drives, and other transportation-related ›arts. The compound can also be mixed with oil, grease, nd existing liquid and solid lubricants; if the conven- ional lubricant is inadequate, boric acid becomes active s a backup.

'he development of boric acid as a lubricant was judged o be among the top 100 technical achievements in 1991. 'he discovery won both an ***R&D 100 Award*** in 1991 nd an ***Al Sonntag Award*** in 1992. Over 300 companies ıave contacted Argonne to obtain more information and xplore possible collaboration on the practical uses of ›oric acid as a lubricant. Argonne is seeking to team up vith industrial partners to commercialize the use of boric

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Argonne National Laboratory is committed to developing high-quality, cost-effective products that meet the nation's goals of improving energy efficiency, reducing emissions, and manufacturing affordable, advanced-technology vehicles.

The Laboratory has forged partnerships with many firms in the energy and transportation sectors over the past two decades. Our location, right in the nation's heartland and industrial center, makes cooperative research accessible and cost-effective.

Argonne's innovative research in advanced coatings and lubricants is helping to provide solutions to the challenges of creating a new generation of vehicles. These programs are supported by the Department of Energy and U.S. industry.

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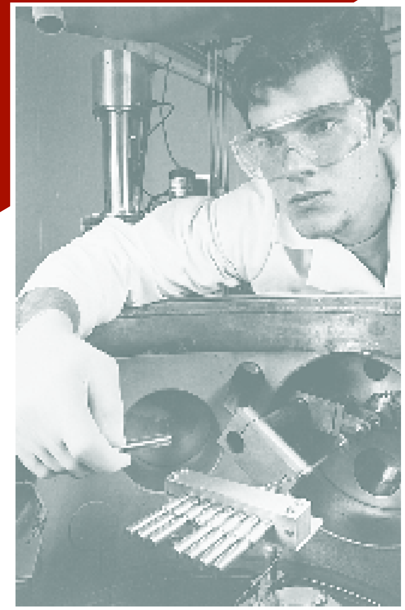
COATINGS & LUBRICANTS



Improved Coatings for Engine Component

Coating Application Technologie

Advanced Lubricant

Industrial Partnership

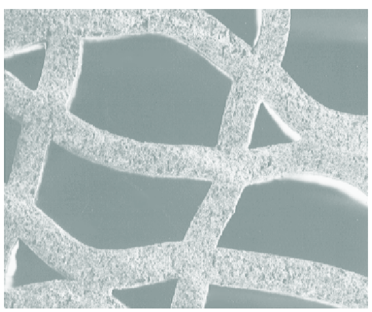
ARGONNE NATIONAL LABORATOR Y

uel-efficient, low-emissions transportation systems, uch as those being developed as part of the Partnership or a New Generation of Vehicles (PNGV), are presenting ew challenges to lubrication engineers and materials cientists. Burning conventional and alternative fuels in utomobile and truck engines currently being developed reates conditions — high service temperatures, corrosive nvironments, and extreme contact pressures — that are ar more demanding than currently available materials nd lubricants can handle.

rgonne scientists are working on solutions that will mprove vehicle performance and fuel efficiency, as vell as reduce emissions. Their work includes developing ubricious and diamond-like carbon coatings and durable, ow-cost solid lubricants to protect engine surfaces rom wear.

Developing state-of-the-art coatings and lubricants to reduce wear and oil consumption, conserve energy, and increase the durability of components in advanced transportation systems.

Lubricious Coatings for Advanced Turbine Engine Applications



Argonne has initiated a DOE-unded research program with the Allison Engine Co. o explore new oxide-based lubricious coatings that can neet the stringent tribological conditions of advanced egenerator core seals. Reliable, low-cost regenerator core are crucial for the successful development of high-performance gas turbine engines for future turbine-engine and hybrid vehicles. Argonne researchers are also exploring new alloys and coating compositions that can promote *in-situ* formation of wear-resistant and lubricious oxides, thus eliminating the use of time-consuming and expensive plasma-spray coatings.

Durable, high-temperature lubricious coatings will conserve energy and cut U.S. dependence on imported oil, because a properly designed regenerator core and seal assembly will increase the fuel efficiency of turbine engines by as much as 30%. This technology may also contribute to a cleaner environment by reducing emissions. The coatings and alloys being developed also have potential in high-temperature air-foil bearings and steel, glass, and aluminum manufacturing operations (e.g., extrusion, punching, stamping, and forging).

Diamond-Like Carbon Coatings

Argonne scientists have also been working to develop and assess the friction and wear properties of diamond-like carbon (DLC) coatings. DLC is an amorphous form of carbon that can be almost as hard as diamond, resists corrosion, and provides remarkably low friction. DLC films can be produced at low temperatures (near room temperature), thereby eliminating the risk of damaging

DLC coatings combine unusual mechanical and chemical properties that make them ideal for a wide variety of engineering applications. Like diamonds, they are very hard and resilient; they are also inert and resistant to acid and salt. They can be good electrical conductors *or* insulators and are virtually transparent. In addition to these properties, DLC films provide very low friction anc high wear resistance. Argonne scientists are testing the performance of the films over a wide range of loads, speeds, and temperatures.

Potential automotive applications of DLC are plentiful:

- Piston rings (to reduce wear at higher cylinder pressures
- Gears and bearing components (to improve durability and permit smaller, lighter components),
- Cams and cam-roller followers (to increase rolling-contact-fatigue resistance),
- Fuel injectors (to permit higher injection pressures), and
- Air-conditioning compressors (to improve the durabilit of components used with R-134a refrigerant).

Working with manufacturers of diesel engines and automotive gas turbines, Argonne researchers are developing processes for depositing the DLC films on metallic and ceramic engine components. One new process employs ions – atoms with an electrical charge – to literally hammer thin films onto surfaces. This process yields coatings that adhere extremely well to the items being coated. Researchers are also investigat-ing new compounds that can be used to protect metal parts from wear brought about by the high temperatures in advanced engines (such as those incorporating